What is claimed is:

1. A system for processing a workpiece, comprising:

(A) a plasma immersion ion implantation reactor, comprising:

(1) an enclosure comprising a side wall and a ceiling and defining a chamber;

(2) a workpiece support pedestal within the chamber having a workpiece support surface facing said ceiling and defining a process region extending generally across said wafer support pedestal;

(3) gas distribution for introducing a process gas containing a first species to be ion implanted into a surface layer of said workpiece;

(4) an RF plasma source power generator coupled across said ceiling or said sidewall and said wafer support pedestal for capacitively coupling RF source power into said process zone;

(5) an RF bias generator having an RF bias frequency and coupled to said workpiece support pedestal for applying an RF bias to said workpiece;

(B) a second wafer processing apparatus;

(C) wafer transfer apparatus for transferring said workpiece between said plasma immersion ion implantation reactor and said second wafer processing apparatus.

2. The system of Claim 1 wherein said second wafer processing apparatus comprises a cleaning species source plasma reactor comprising:

(1) a source of cleaning species precursor gases;

(2) a passage coupling said cleaning species source plasma reactor to said plasma immersion ion implantation reactor.

3. The system of Claim 2 wherein said cleaning

species precursor gases comprise a fluorine-containing species.

4. The system of Claim 2 wherein said cleaning species precursor gases comprise a hydrogen-containing species.

5. The system of Claim 1 wherein said second wafer processing apparatus comprises:

an optical metrology chamber for obtaining a measurement of ion implantation in a workpiece;

a process controller coupled to receive measurements from said optical metrology chamber for controlling said plasma immersion ion implantation reactor.

6. The system of Claim 1 wherein said second wafer processing apparatus comprises:

an ion beam implantation apparatus for ion implanting a second species into said surface layer of said workpiece.

7. The system of Claim 6 wherein said surface layer is a semiconductor material, and said first and second species are dopant impurities of opposite conductivity types relative to said semiconductor material.

8. The system of Claim 1 wherein said second wafer processing apparatus comprises:

a second plasma immersion ion implantation reactor for ion implanting a second species into said surface layer of said workpiece.

9. The system of Claim 8 wherein said surface layer is a semiconductor material, and said first and second species are dopant impurities of opposite conductivity types relative to said semiconductor material.

10. The system of Claim 1 wherein said second wafer processing apparatus comprises an anneal chamber.

11. The system of Claim 1 wherein said second wafer processing apparatus comprises:

a photoresist strip chamber.

12. The system of Claim 1 wherein said second wafer processing apparatus comprises a wet clean chamber.

13. The reactor of Claim 1 wherein said RF bias frequency is sufficiently low to enable ions traversing the plasma sheath to attain an energy corresponding to a peak-to-peak voltage of said bias power generator.

14. The reactor of Claim 13 wherein said RF bias frequency is sufficiently high to limit RF voltage drops across dielectric layers on said workpiece support pedestal to less than a predeterminded fraction of plasma sheath voltage near said workpiece support.

15. The reactor of Claim 14 wherein said predetermined fraction corresponds to about 10%.

16. The system of Claim 1 wherein said RF source power generator is coupled to said ceiling or said sidewall and said wafer support pedestal is coupled to an RF return potential.

17. The system of Claim 1 wherein said RF source power generator is coupled to said wafer support pedestal and said ceiling or said sidewall is coupled to an RF return potential.

18. The apparatus of Claim 1 wherein said RF bias generator has a bias RF frequency that is sufficiently low

for ions in a plasma sheath near said workpiece to follow electric field oscillations across said sheath at said bias frequency.

19. The apparatus of Claim 18 wherein said bias RF frequency is sufficiently high so that RF voltage drops across dielectric layers on said workpiece do not exceed a predetermined fraction of the RF bias voltage applied to said workpiece support.

20. The apparatus of Claim 19 wherein said predetermined fraction corresponds to about 10%.

21. The apparatus of Claim 1 wherein said RF bias generator has a bias frequency between 10 kHz and 10 MHz.

22. The apparatus of Claim 1 wherein said RF bias generator has a bias frequency between 50 kHz and 5 MHz.

23. The apparatus of Claim 1 wherein said bias generator has a bias frequency between 100 kHz and 3 MHz.

24. The apparatus of Claim 1 wherein said bias generator has a bias frequency of about 2 MHz to within about 5%.

25. A system for processing a workpiece comprising a plurality of plasma immersion ion implantation reactors, each of said plasma immersion ion implantation reactors comprising:

(1) an enclosure comprising a side wall and a ceiling and defining a chamber;

(2) a workpiece support pedestal within the chamber having a workpiece support surface facing said ceiling and defining a process region extending generally across said wafer support pedestal;

(3) gas distribution for introducing a process gas containing a first species to be ion implanted into a surface layer of said workpiece;

(4) an RF plasma source power generator coupled across said ceiling or said sidewall and said wafer support pedestal for capacitively coupling RF source power into said process zone;

(5) an RF bias generator having an RF bias frequency and coupled to said workpiece support pedestal for applying an RF bias to said workpiece.

26. The system of Claim 25 further comprising a wafer handling apparatus coupled to each of said plurality of plasma immersion ion implantation reactors.